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FOREST SERVICE, U. S. DEPT. OF AGRICULTURE, 6816 MARKET STREET, UPPER DARBY, PA.

E**xperiment Station**

LAND DISTURBANCES FROM STRIP-MINING IN EASTERN KENTUCKY

6. SOUTHWESTERN COAL RESERVE DISTRICT

Abstract. Results of an airphoto survey to determine the extent of land disturbance by coal mining and by coal-haul roads in one of the six coal-reserve districts of eastern Kentucky. Describes the district, forest cover, physiography and geology, and distribution and physical characteristics of the acres disturbed in this district.

Open-pit or strip-mining—primarily for coal—has expanded rapidly in eastern Kentucky during the past 15 years. Information about the amount, location, and general characteristics of the disturbed areas is necessary for appraising the economic impacts and overall effects of strip-mining in that section of the state, for planning reclamation programs, and for determining research needs and priorities. The Northeastern Forest Experiment Station made a survey of eastern Kentucky to obtain reliable estimates of the acreage disturbed both by the mining itself and by the associated coal-haul roads, and to provide relevant information about the disturbed areas. The survey was based on aerial photographs of all stripped areas as of October 1964.

The survey was broken down in accordance with the six subdivisions or coal-reserve districts delineated by the U. S. Geological Survey.¹ Thus there will be a series of six reports, of which this is the sixth and last.

The method used in our survey was a modification of forest-survey procedure. A 3-by-6-inch transparent template with 25 dots per square inch was positioned over the center of each photograph. Areas on the photographs that appeared to be stripped land or coal-haul roads were

¹Huddle, J. W., F. J. Lyons, H. L. Smith, and J. C. Ferm. COAL RESERVES OF EASTERN KENTUCKY. U. S. Geol. Survey Bull. 1120, 147 pp., 1963.

examined stereoscopically to determine important characteristics, and the amount of area in various categories was estimated by dot counts.

The Southwestern Coal Reserve District

The "mechanical" method of strip-mining—using horse-drawn plows and scrapers to remove the overburden—probably began in Kentucky about 1870, at London.² The first steam shovel to strip-mine coal in Kentucky began operation near Lily, south of London, in 1905. Therefore we consider the Southwestern District the cradle of strip-mining in eastern Kentucky.

This 2.4-million-acre District includes all of Clay, Knox, Laurel, Jackson, Lee, McCreary, and Owsley Counties as well as parts of Bell, Clinton, Estill, Pulaski, Rockcastle, Wayne, and Whitley Counties (fig. 1). Clay, Knox, Laurel, and Whitley Counties each had 2,000 or more acres disturbed by strip-mining.

The earliest recorded production of coal in Kentucky was from Lee County in 1790. No other District recorded production until 1824, when mines in Greenup County opened. Before the 1840's half of the production in eastern Kentucky came from this District. Today, the District produces less than 10 percent of eastern Kentucky coal. Through 1955, total recorded production from the District's mines was 144 million tons.

In 1962, production totaled 4.8 million tons. Of this, 1.6 million tons or 33 percent of the total production came from strip-and auger-mining.³ Fifty-eight percent of the tonnage from open-pit mining came from strip mines, and the remainder came from auger mining.

The total disturbed acreage in the District by 1947 was 547 acres.⁴ This was located in Laurel and Whitley Counties. About three-fourths of this acreage was less than 5 years old.

The original coal reserves (measured, indicated, and inferred) in the District total 4.6 billion. Of these about 400 million are in beds more than 42 inches thick, and 2.2 billion tons are in beds over 28 inches thick. Clay, Knox, Whitley, and McCreary Counties contain 67 percent of the reserves. The coal reserves in the Breathitt formation represent 69 percent of the total, and the coal reserves in the Lee formation represent 31 percent of the total.

²Montgomery, Robert. STRIP MINING IN KENTUCKY. Kentucky Dep. Natural Resources, 56 pp., 1965.

³Mandt, A. H. ANNUAL REPORT. Ky. Dep. Mines and Minerals, 166 pp., 1963.

⁴Merz, Robert W. CHARACTER AND EXTENT OF LAND STRIPPED FOR COAL IN KENTUCKY. Ky. Agr. Exp. Sta. Circ. 66, 278 pp., 1949.

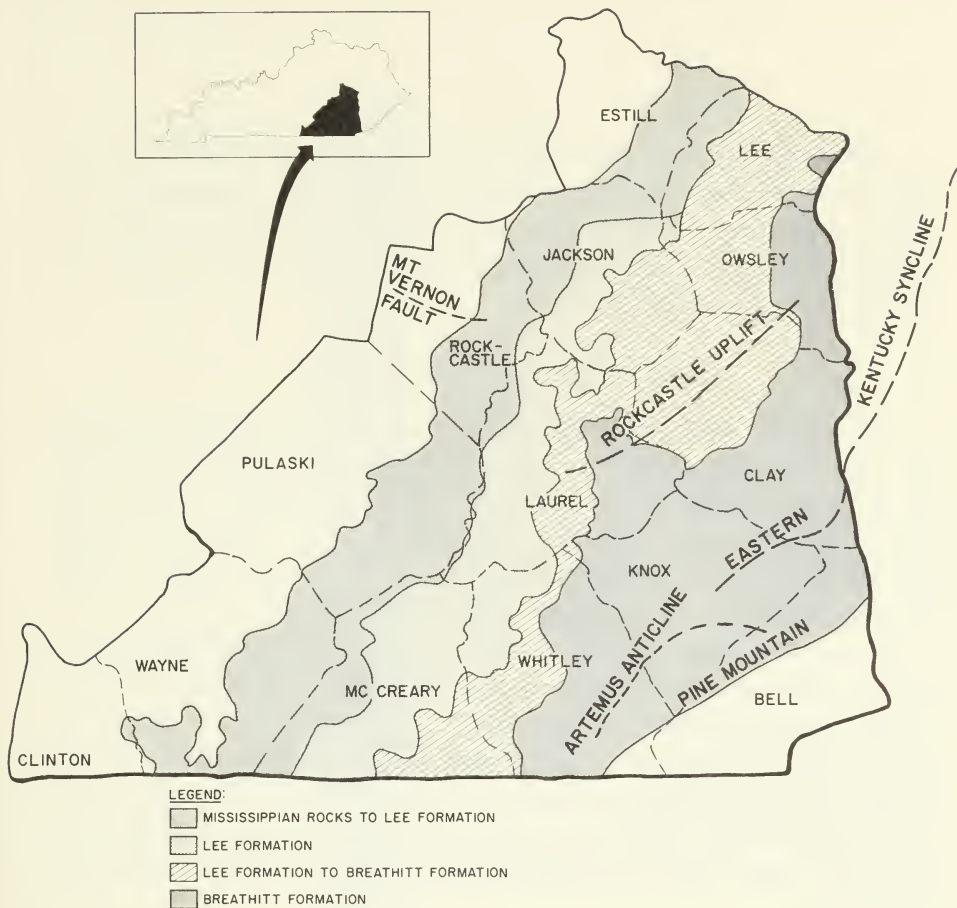


Figure 1.—Geologic and geographic features of the Southwestern Coal Reserve District.

Forest Cover

Forests cover about 77 percent of the District's land area.^{5 6} In the rugged eastern mountains most of the non-forest land occurs in the valley bottoms. To the west along the Cumberland Plateau there is no pattern for forest and non-forest use. About half of the strip and auger mines are located on the upper slopes or ridges. Seventy-eight percent of the disturbed land has forest immediately below the mine site.

⁵United States Forest Service and Kentucky Department of Natural Resources. BASIC FOREST RESOURCE STATISTICS, SOUTHERN CUMBERLAND UNIT, KENTUCKY, 1963. 1965. (Unpublished preliminary report on file at Kentucky Division of Forestry and the Northeastern Forest Experiment Station, Upper Darby, Pa.)

⁶United States Forest Service and Kentucky Department of Natural Resources. BASIC FOREST RESOURCE STATISTICS, PENNYROYAL UNIT, KENTUCKY, 1963. 1965. (Unpublished preliminary report on file at Kentucky Division of Forestry and the Northeastern Forest Experiment Station, Upper Darby, Pa.)

Fifty-three percent of the acreage in forests is in sawtimber-size stands. White oak, hickory, and central mixed hardwood types predominate. The southern pine and oak-pine types represent 21 percent of the total forest acreage. This is the highest percentage of these types for all coal reserve districts in eastern Kentucky.

Physiography and Geology

The District has three physiographic provinces; from west to east they are: the Pottsville escarpment, characterized by steep sandstone cliffs and gorges; the Cumberland Plateau with modified topography; and the eastern Mountains with V-shaped valleys, steep slopes, and narrow ridges. The Kentucky River drains the District on the north and east, and the Cumberland River drains the remainder of the District.

Several minor features control the structural geology and affect correlation of coal seams within the District. The most prominent of these features are the Mount Vernon fault in Rockcastle County; the Rockcastle uplift in Laurel, Clay, and Owsley Counties; and the Artemus anticline in Whitley and Knox Counties. The southwesterly extension of the eastern Kentucky syncline in Clay and Knox Counties and the Pine Mountain fault along the southeastern boundary of the District are also important.

We recognize four zones in the District that characterize the surface occurrence of rocks from the Mississippian era and the Lee and Breathitt formations of the Pennsylvanian era. These zones and the percent of the total District area they occupy are as follows: transition from Mississippian rocks to the Lee formation, 27 percent; the Lee formation, 16 percent; the transition from the Lee formation to the Breathitt, 22 percent; and the Breathitt formation, 35 percent.

In the Lee formation the authors of *Coal Reserves of Eastern Kentucky* recognize three commercially important coal beds. However, geologic quadrangle maps of Pulaski and Rockcastle Counties show another commercial coal bed. Because of this disagreement in nomenclature, we consider the coal seam in Pulaski and Rockcastle Counties as the fourth commercially important coal bed in the Lee formation. All of these have been strip-mined (fig. 2).

Fifteen coal beds have been named in the Breathitt formation, and 13 of these are thick and extensive enough to contribute to the total reserves. Of these, seven have been strip- or auger-mined.

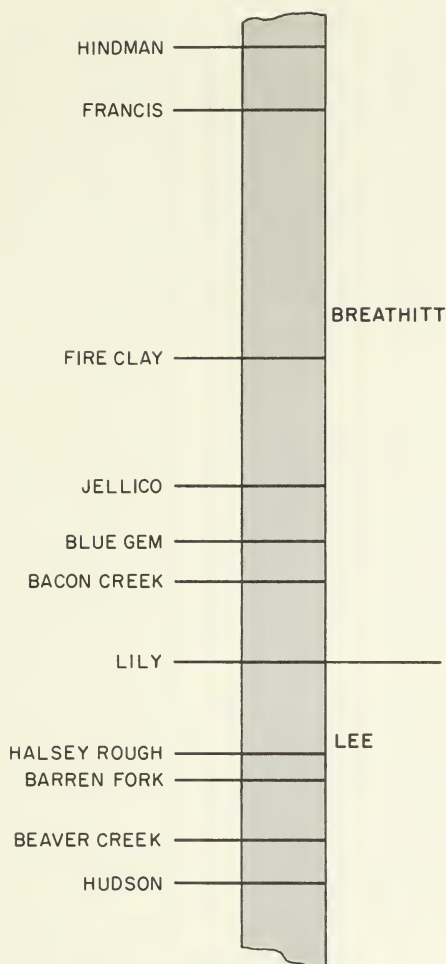


Figure 2.—Generalized geologic column for coal seams strip- and auger-mined in the Southwestern Coal Reserve District.

Distribution of Stripped Areas

By 1964 strip- and auger-mining (excluding coal-haul roads) had disturbed 16,995 acres in the District (table 1). Clay County (4,290 acres or 1.4 percent of the land area) and Whitley County (3,933 acres or 1.3 percent of the land area) had the most disturbance. Knox and Laurel Counties each had over 2,000 acres of disturbance, and Bell and McCreary Counties had over 1,000 acres of disturbance.

Where the Breathitt formation outcrops, 14,840 acres or 11 percent of the land area had been disturbed. For areas where the Lee formation is exposed the disturbance affected 2,155 acres or 0.2 percent of the land area. Most of this disturbance occurs in the Mississippian to Lee transition zone.

Table 1.—Disturbed area by counties and coal meams in the
Southwestern Coal Reserve District, in acres

Formation	Coal Seam	County											Total	
		Bell	Clay	Jackson	Knox	Laurel	Lee	McCreary	Owsley	Pulaski	Rock- castle	Wayne		Whitley
Lee	Hudson	—	—	34	—	—	—	—	—	—	—	—	—	34
	Beaver Creek	—	—	—	—	—	—	116	—	26	—	107	271	520
	Barren Fork	—	—	134	—	—	—	232	—	—	—	—	322	688
	Halsey Rough	—	—	—	—	—	—	—	—	584	329	—	—	913
Breathitt	Lily	—	3,629	—	—	1,954	77	966	383	—	—	—	1,132	8,141
	Bacon Creek	—	112	—	15	—	—	—	—	—	—	—	12	139
	Blue Gem	16	386	—	174	—	—	—	—	—	—	—	102	678
	Jellico	430	73	—	1,187	69	—	—	—	—	—	—	1,512	3,271
	Fireclay	—	90	—	1,028	138	—	—	—	—	—	—	582	1,838
	Francis	281	—	—	—	—	—	—	—	—	—	—	—	281
	Hindman	463	—	—	29	—	—	—	—	—	—	—	—	492
Total acreage disturbed		1,190	4,290	168	2,433	2,161	77	1,314	383	610	329	107	3,933	16,995
Percent of District land area disturbed		1.5	1.4	0.1	1.0	0.8	0.1	0.5	0.3	0.4	0.3	0.1	1.3	0.7

The uncorrelated Halsey Rough coal seam had the greatest acreage of disturbance from Lee formation coal beds. In decreasing acreage of disturbance were the Barren Fork and the Beaver Creek coal beds. A very small acreage was disturbed by surface mining from the Hudson coal seam.

Over half of the disturbance (8,141 acres) from coal seams of the Breathitt formation resulted from mining the Lily coal seam. This seam occurs at the base of the Breathitt formation. Next in importance in terms of acreage disturbed were the Jellico and Fireclay coal seams. The Bacon Creek, Blue Gem, Francis, and Hindman coal seams also have been strip- or auger-mined.

Physical Characteristics of Disturbed Areas

There are two basic types of strip-mining in the eastern Kentucky coal field: contour- or rim-stripping and area-stripping. Auger-mining usually is employed as a supplement to contour-mining; it is a means for working a seam beyond the point where removal of the overburden by stripping is economically feasible. In this District 92 percent of the stripping has resulted from contour-mining.

In the contour-stripping, 14 percent of the disturbed area was on or above the highwalls, 45 percent was in pits, inslopes, and leveled or unleveled benches above the outslopes, and 41 percent was on outslopes. Of the 6,410 acres in outslopes, 609 acres or 9.5 percent were in slides.

Forty percent of the contour-stripping had been leveled, and 9 percent had been partially leveled. The remaining 51 percent that is unleveled is assumed to have occurred before 1954, when the Commonwealth of Kentucky enacted a reclamation law.

The 1,360 acres of area-stripping occurred as frequently on the upper slopes and ridges as on the lower slopes and in the valleys. The proportionate distribution of the disturbed area by bank position was as follows: on or above the highwall, 9 percent; pit, inslope, leveled and unleveled benches above the outslope, 70 percent; and outslopes, 21 percent. Slides or slumps occurred on 8 percent or 23 acres of the 286 acres in outslopes.

Forty-three percent of the area stripping had been leveled, and 10 percent had been partially leveled. The remaining 47 percent was considered unleveled.

In all stripping operations, the operator must build and maintain a network of roads for hauling coal from the mines. In this survey we classified haul roads as: Primary (running from a public road to the mine); secondary (joining two pits or serving as spurs for primary roads); and third class (service roads and temporary haul roads).

Table 2.—Coal-haul road disturbed acreage and mileage by county and road classes in the Southwestern Coal Reserve District

County	Class I		Class II		Class III		Total	
	<i>Acres</i>	<i>Miles</i>	<i>Acres</i>	<i>Miles</i>	<i>Acres</i>	<i>Miles</i>	<i>Acres</i>	<i>Miles</i>
Bell	86	19.1	28	6.2	20	4.4	134	29.7
Clay	119	26.5	24	5.3	2	.4	145	32.2
Jackson	—	—	5	1.1	—	—	5	1.1
Knox	184	40.9	79	17.6	20	4.4	283	62.9
Laurel	56	12.5	20	4.4	13	2.9	89	19.8
Lee	5	1.1	3	.7	—	—	8	1.8
McCreary	43	9.5	23	5.1	5	1.1	71	15.7
Owsley	20	4.4	—	—	—	—	20	4.4
Pulaski	24	5.3	14	3.1	5	1.1	43	9.5
Rockcastle	31	6.9	28	6.2	2	.4	61	13.5
Wayne	8	1.8	5	1.1	2	.4	15	3.3
Whitley	140	31.1	128	28.4	21	4.7	289	64.2
Total	716	159.1	357	79.2	90	19.8	1,163	258.1

We estimate that 1,163 acres had been disturbed by coal-haul roads in this District. This figure was computed directly from the dot counts on the aerial photographs. After determining by field measurement that the average width of disturbance was 37 feet, we determined that the average road disturbance was 4.5 acres per mile. Therefore, we estimate there are 258 miles of coal-haul roads in the District. This mileage was distributed among the classes as follows: primary, 159 miles; secondary, 79 miles; and third class, 20 miles (table 2). On the average, there are 66 acres of strip-mining disturbance for each mile of coal-haul road.

Eighty-eight percent of these roads were built through forested land. Over 70 percent were built along slopes away from the valley bottoms and streams. About 15 percent were built within 100 feet of streams.

—WILLIAM T. PLASS

Plant Ecologist
Northeastern Forest Experiment Station
Forest Service, U. S. Department of Agriculture
Berea, Kentucky